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Rubber, vulcanized or thermoplastic — Determination of adhesion to a rigid substrate —

Part 2: Adhesion of a soft thermoplastic elastomer layer

Caoutchouc vulcanisé ou thermoplastique — Détermination de l'adhérence à un substrat rigide —

Partie 2: Adhérence d'une couche d'élastomère thermoplastique souple

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Foreword

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This document was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products,* Subcommittee SC 2, *Testing and analysis.*

A list of all parts in the ISO 813 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Nowadays it is common to use combinations of materials aimed at achieving special properties for parts of a product. Thermoplastic elastomers (TPEs) are used in a large percentage of these applications for functional, visual, acoustic, haptic and tactile reasons, with injection moulding used as the joining method in the majority of cases.[3,4] Due to their thermoplastic nature, TPE materials are gaining importance steadily in this area relative to vulcanized rubber.

Due to the wide variety of TPE types encountered nowadays and the large number of manufacturers, it is difficult to reach comparative conclusions regarding the bond strength between two materials. Accordingly, the purpose of this document is to specify a peel test procedure specifically for measuring the adhesion of a TPE to a rigid substrate.

Rubber, vulcanized or thermoplastic — Determination of adhesion to a rigid substrate —

Part 2:
Adhesion of a soft thermoplastic elastomer layer

WARNING 1 — Persons using this document should be familiar with normal laboratory practice. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to determine the applicability of any other restrictions.

WARNING 2 — Certain procedures specified in this document can involve the use or generation of substances, or the generation of waste, that could constitute a local environmental hazard. Reference should be made to appropriate documentation on safe handling and disposal after use.

1 Scope

This document specifies a test method for assessing the peel strength of a thermoplastic elastomer (TPE) to a rigid substrate. It is mainly applicable to soft components in the Shore A hardness range.

This document specifies a test piece but not the injection moulding tool for its manufacture. Hence, it is possible that different results are obtained for test pieces produced using different injection moulding tools.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO 6133, *Rubber and plastics — Analysis of multi-peak traces obtained in determinations of tear strength and adhesion strength*

ISO 18899:2013, *Rubber — Guide to the calibration of test equipment*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Principle

The force required to cause separation of a strip of a TPE covering a rigid substrate is measured, the angle of separation being 90° and the width and thickness of the TPE being fixed within specified limits.

Special TPE material descriptions are listed in Annex C for better understanding.

5 Apparatus

5.1 Tensile testing machine

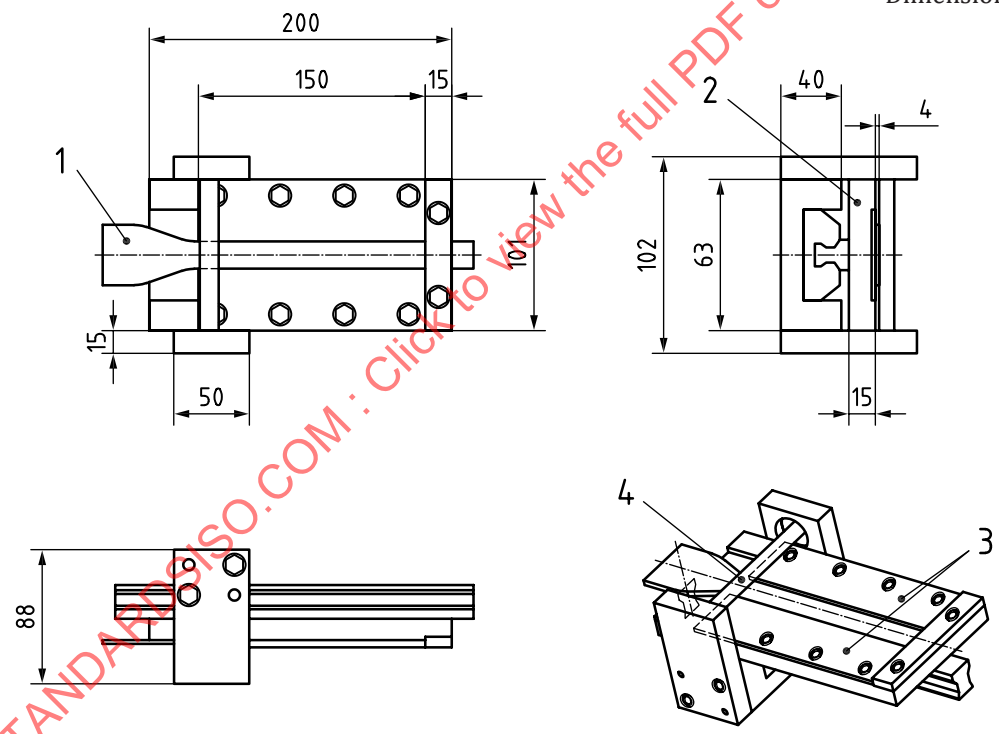
A tensile testing machine in accordance with class 1 of ISO 5893 shall be used to perform the peel test.

5.2 Test trolley

An example of a suitable test trolley used for clamping the test piece is shown in Figure 1 and the clamping arrangement in Figure 2. The trolley mounting shall be such that the force required to set the test trolley, including the guide pulley, in motion in the horizontal direction does not exceed 4 N.

All dimensions are just a guide. The chosen dimension of the test specimen shall fit securely into the trolley.

Dimensions in millimetres

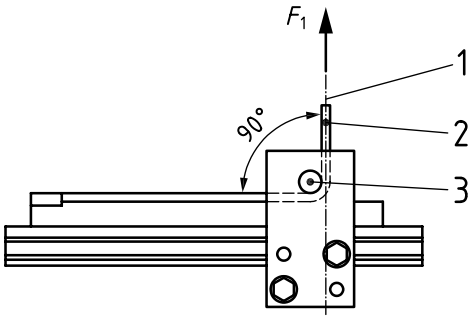


Key

1 clamped test specimen
2 mounting
3 clamping plates
4 guide pulley, free rotation shall be possible, a diameter of 8 mm to 9 mm is recommended

Figure 1 — Test trolley

Dimensions in millimetres



Key

1 tensile axis
2 free end of the soft component
3 guide pulley
F_1 direction of the force the soft component is pulled from the rigid substrate

Figure 2 — The test piece clamping arrangement

6 Calibration

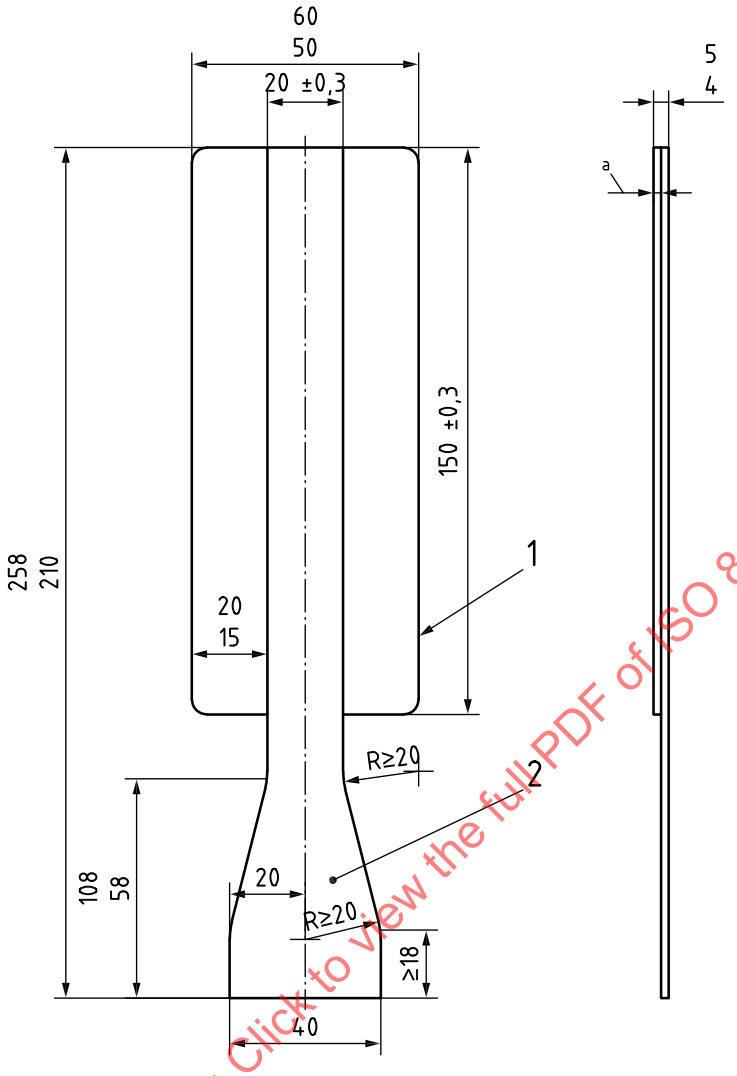
The test apparatus shall be calibrated in accordance with the schedule given in Annex B.

7 Test pieces

7.1 Form and dimensions

The test piece shown in Figure 3 shall be used. The standard wall thickness for the soft component shall be (2 ± 0,2) mm, but in the case of a TPE with a low hardness, the soft component's wall thickness can be increased to (3 ± 0,2) mm.

Dimensions in millimetres



Key

1 rigid substrate
2 soft component
a 2-3 ± 0,2

Figure 3 — Test piece

7.2 Test piece fabrication using the injection moulding method

The test pieces shall preferably be fabricated using a two-component injection moulding method in accordance with the material manufacturer's processing instructions. The recommended technique is the core-back technique.[4] The tool's surface in the region of the subsequent bond for the pre-moulded hard component shall have a surface roughness of RA ranging from 2,20 µm to 3,20 µm according to ISO 21920-1, created by eroding the surface. The sequence of events in the moulding process shall proceed without interruption.

All the surfaces of the test piece should be free from visible defects such as flow marks, sink marks and air inclusions. Overmoulding at the interface region of the materials used should be avoided as far as possible. No overmoulding shall be present at the hard component's end face (strap-side). Possibly, a means of compensating for shrinking of the hard component will be necessary. The tool design shall exclude the formation of a weld line on the hard component. Note the examples of defects shown in Figure 4.

7.3 Test piece with inserted rigid substrate

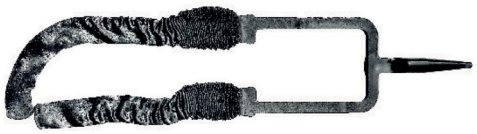
Test pieces with all types of rigid substrates can be produced using the insertion technique.

7.4 Number of test pieces

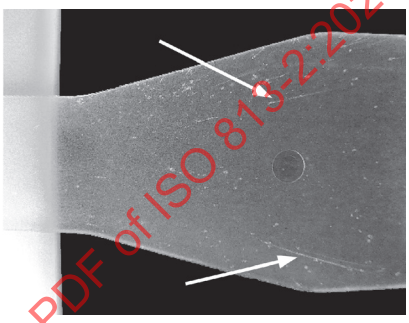
At least five test pieces shall be tested. Test pieces already stressed or damaged at the interface region shall not be used.

8 Conditioning

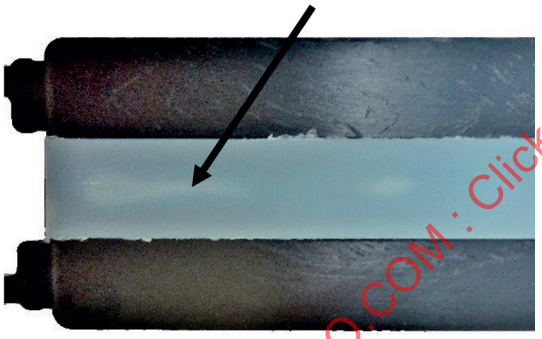
Test pieces shall be conditioned for at least 16 h in a standard atmosphere of (23 ± 2) °C / (50 ± 10) % in accordance with ISO 23529.



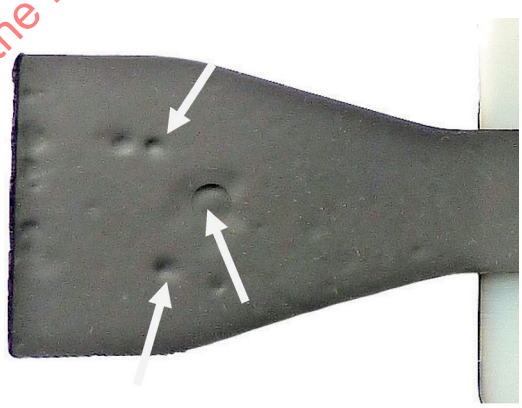
a) hard component jetting



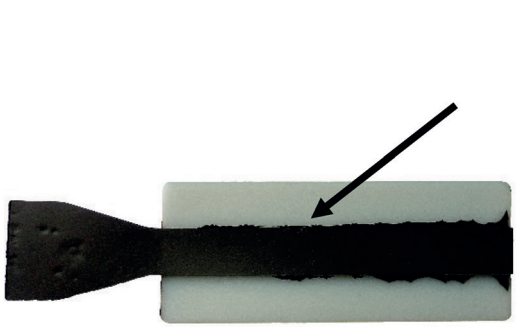
b) flow marks



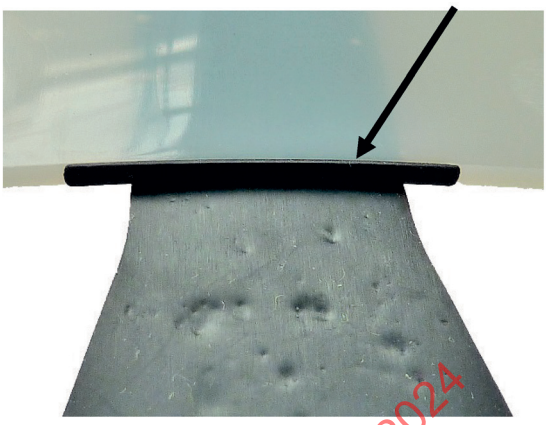
c) air inclusions



d) sink marks



e) overmoulding at the interface region



f) overmoulding at the hard component's end face

Figure 4 — Examples of defects

9 Test conditions

Carry out testing in a standard atmosphere of (23 ± 2) °C/(50 ± 10) % in accordance with ISO 23529.

10 Procedure

Insert the test piece completely into the test trolley and fix it in such a way that it cannot slide out of the trolley during testing.

Attach the trolley to the lower mounting of the test machine. Clamp the free end of the soft component in the upper grips of the tensile machine such that it is at an angle of 90° to the specimen's interface, and the stripping direction corresponds to the testing machine's tensile axis (see Figure 2). Ensure that the soft component's free end fits against the guide pulley and is not stretched or subjected to tension. Accurate mounting of the test piece can be achieved, for example, by using an adjustable guide rail. The test trolley shall be able to move freely along its horizontal axis in the clamping system.

Peel the test piece at 100 mm/min. In order to obtain evaluable results, it is recommended to use the distance the test trolley moves rather than the separation of the tensile machine grips as a measure of the length peeled.

11 Expression of results

11.1 Peel strength

Calculate the peel strength W_S, in N/mm, using Formula (1):

$$W_S = \frac{F}{b} \tag{1}$$

where

F is the adhesion strength in N calculated in accordance with ISO 6133;

b is the soft component's width at the interface in mm.

11.2 Fracture pattern

Visually assess the test piece fracture pattern using the classification system given in this subclause. The decisive feature is the dominant fracture pattern without edge effects (see Figure 5).

Characterize the nature of the test piece failure using one or two characters describing the fracture pattern. The first character describes the residue of TPE on the hard component (see Figure 5). The second character describes where TPE strip fails during the measurement (see Figure 6).

A 0 % TPE residue on the rigid substrate with complete peeling;

B (1–50) % TPE residue on the rigid substrate;

C (51–99) % TPE residue on the rigid substrate;

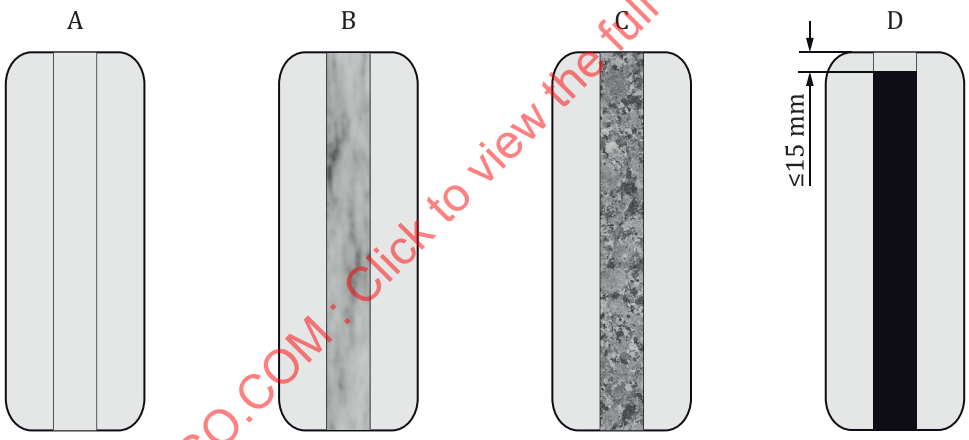
D Failure of the soft component — peeled length of less than 15 mm is allowed;

A/D mixed fracture pattern “A” and “D”, with first “A” and then the TPE strip failing;

B/D mixed fracture pattern “B” and “D”, with first “B” and then the TPE strip failing;

C/D mixed fracture pattern “C” and “D”, with first “C” and then the TPE strip failing;

E sample destruction with hard component/rigid substrate residue on the TPE (no figure).



Key

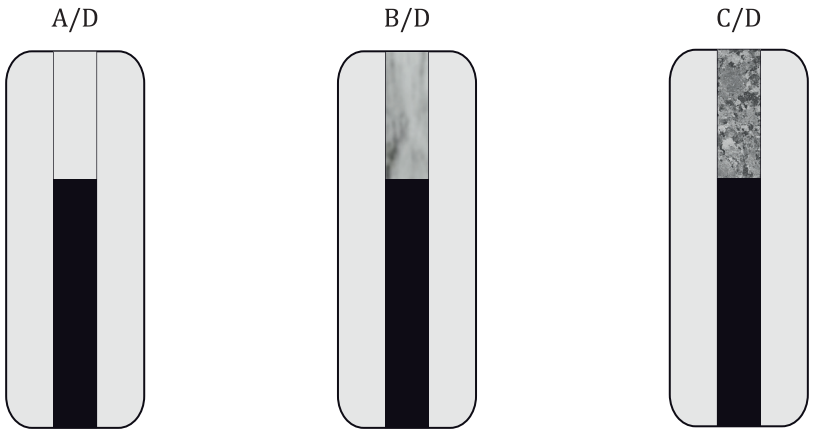
A no TPE residue on the rigid substrate

B (1–50) % TPE residue on the rigid substrate, no TPE break

C (51–99) % TPE residue on the rigid substrate, no TPE break

D sample destruction — soft component torn off (≤ 15 mm)

Figure 5 — Fracture patterns



Key

A/D no TPE residue of on the rigid substrate; TPE strip torn off

B/D (1–50) % TPE residue on the rigid substrate; TPE strip torn off

C/D (51–99) % TPE residue on the rigid substrate; TPE strip torn off

Figure 6 — Fracture patterns continued

For fracture patterns A/D, B/D and C/D indicate the peeling length between the beginning and the TPE strip torn off (see Figure 6).

12 Test report

The test report shall include the following information:

a) sample details:

   1) a full description of the sample and its origin including the TPE material and the rigid substrate used;

   2) the method of preparation of the test piece from the sample including the fabrication process, injection moulding/insert moulding and injection direction of the soft component;

   3) the soft component wall thickness;

   4) any defects present on the test piece;

b) test method:

   1) a full reference to the test method used, i.e. this document (ISO 813-2:2024);

c) test details:

   1) the laboratory temperature and humidity;

   2) the time and temperature and humidity of conditioning prior to test;

   3) the temperature of test, if other than standard laboratory temperature and the relative humidity;

   4) details of any procedures not specified in this document;

d) test results:

   1) the number of test pieces used;

   2) the individual and the mean test results;

3) a record of the force/distance curve, quoting the peel strength and the spread of force peaks in accordance with ISO 6133;

4) the classification (letters A to E) and optional photographs of the fracture patterns;

5) for classifications A/D, B/D and C/D, report the peeling length;

e) date of test.

Annex A is an example of the documentation of the injection moulding parameters and the results of the test report.

Annex A
(informative)

Example of listing the test results

A.1 Protocol for results

Table A.1 is a sample protocol for the expression of results.

Table A.1 — Example of protocol

Results of peel tests in accordance with ISO 813-2 on …			
Rigid substrate			
TPE			
Soft component's wall thickness	☐ 2 mm	☐ 3 mm	☐ _____ mm
Defects present on the test specimen			
Storage conditions			
Curve shape (diagram)			
Peel strength W_S, in N/mm, with the adhesion strength *F* and the soft component width *b*			
Number of tested specimens			
Spread of force peaks, in N			
Classification (A to E) of the fracture pattern with colour photograph, if necessary			
Indication of the injection direction of the soft component in proportion to the rigid substrate			
Non-standard conditions			

A.2 Description of injection moulding parameters

Table A.2 is an example form for the description of process parameters.

Table A.2 — Description of process parameters (injection moulding)

Process parameters	Material	Chosen setting	The materials manufacturer's specification
Cylinder temperature in °C	Rigid substrate		
	TPE		
Tool temperature in °C	Rigid substrate		
	TPE		
Volume flow rate in cm^3/s	Rigid substrate		
	TPE		
Packing pressure in bar	Rigid substrate		
	TPE		
:			
:			
:			